CLAIMS

I/We claim:

[c1] 1. A system for processing microfeature workpieces, comprising:

a vessel configured to receive a processing fluid, the vessel having a process location positioned at a process plane to receive a microfeature workpiece;

a workpiece support positioned at least proximate to the vessel, the workpiece support being positioned to carry a microfeature workpiece at the process location of the vessel during processing;

a paddle device having at least one paddle positioned at least proximate to the process location, wherein at least one of the workpiece support and the at least one paddle is movable relative to the other while the workpiece support carries a microfeature workpiece; and

an electrode support positioned to carry a thieving electrode remote from the process plane.

[c2] 2. The system of claim 1, further comprising the thieving electrode.

[c3] 3. The system of claim 1, further comprising:

the thieving electrode;

a contact electrode carried by the workpiece support and positioned to make electrical contact with a microfeature workpiece when the workpiece support carries the microfeature workpiece;

at least one anode spaced apart from the process location; and

one or more power supplies coupled among the contact electrode, the thieving electrode and the at least one anode to provide current to the at least one anode at a potential greater than potentials provided to the thieving electrode and the contact electrode.

[c4] 4. The system of claim 1 wherein the electrode support includes a plurality of electrode chambers at least partially separated from each other by dielectric barriers, gaps between the dielectric barriers forming a corresponding plurality of virtual electrode locations spaced apart from the process location.

[c5] 5. The system of claim 1 wherein the at least one paddle includes a plurality of paddles, with the paddles being movable back and forth relative to the process location along a generally linear motion path, and wherein the system further comprises an at least partially enclosed paddle chamber positioned between the electrode support and the process location, the paddle chamber housing the plurality of paddles.

[c6] 6. A system for processing microfeature workpieces, comprising:

a vessel configured to receive a first processing fluid, the vessel having a process location positioned at a process plane to receive a microfeature workpiece;

a workpiece support positioned at least proximate to the vessel, the workpiece support being positioned to carry a microfeature workpiece at the process location of the vessel during processing;

a paddle device having at least one paddle positioned at least proximate to the process location, wherein at least one of the workpiece support and the at least one paddle is movable relative to the other while the workpiece support carries a microfeature workpiece; and

a nozzle coupleable to a source of a second processing fluid and positioned above the process location to direct a stream of the second processing fluid toward a microfeature workpiece carried by the workpiece support.

[c7] 7. The system of claim 6 wherein the workpiece support is movable between a first position to carry a microfeature workpiece in contact with the first

processing fluid at the process location, and a second position above the first position to place the microfeature workpiece in a path of the stream of second processing fluid directed by the nozzle.

[c8] 8. The system of claim 6, further comprising an electrode support positioned to be in fluid communication with the process location, the electrode support having a plurality of electrode chambers at least partially separated from each other by barriers, gaps between the barriers forming a corresponding plurality of virtual electrode locations spaced apart from the process location.

[c9] 9. The system of claim 6 wherein the at least one paddle includes a plurality of paddles, with the paddles being movable back and forth relative to the process location along a generally linear motion path, and wherein the system further comprises an at least partially enclosed paddle chamber positioned between the electrode support and the process location, the paddle chamber housing the plurality of paddles.

[c10] 10. A system for processing microfeature workpieces, comprising:

a vessel configured to receive a processing fluid, the vessel having a process location positioned at a process plane to receive a microfeature workpiece;

a workpiece support positioned at least proximate to the vessel, the workpiece support being positioned to carry a microfeature workpiece at the process location of the vessel during processing;

a paddle device having at least one paddle positioned at least proximate to the process location, wherein at least one of the at least one paddle and the workpiece support is movable relative to the other while the workpiece support carries a microfeature workpiece; and

an electrode support positioned to be in fluid communication with the process location, the electrode support having a plurality of

electrode chambers at least partially separated from each other by barriers, gaps between the barriers forming a corresponding plurality of virtual electrode locations spaced apart from the process plane.

[c11] 11. The system of claim 10, further comprising a plurality of electrodes disposed in the corresponding plurality of electrode chambers.

[c12] 12. The system of claim 10, further comprising an electrode thief spaced apart from the process plane, the electrode thief being positioned in fluid communication with the process location to receive ions from the processing fluid that would otherwise attach to the microfeature workpiece.

[c13] 13. A system for processing microfeature workpieces, comprising:

a vessel configured to receive a processing fluid, the vessel having a process location positioned at a process plane to receive a microfeature workpiece;

a workpiece support positioned at least proximate to the vessel, the workpiece support being positioned to carry a microfeature workpiece at the process location of the vessel during processing;

a magnet positioned at least proximate to the process location, the magnet being positioned to impose a magnetic field at the process location to orient material deposited on a microfeature workpiece; and

an electrode support positioned to carry at least one electrode in fluid communication with the process location, the electrode support being movable relative to the vessel between a process position and a removed position along a motion path that does not pass through the process plane.

[c14] 14. The system of claim 13 wherein the magnet includes a permanent magnet.

[c15] 15. The system of claim 13, further comprising the at least one electrode, and wherein the at least one electrode is one of a plurality of electrodes spaced apart from the process plane.

[c16] 16. The system of claim 13, further comprising the at least one electrode, and wherein the at least one electrode includes a thieving electrode spaced apart from the process plane.

[c17] 17. The system of claim 13, further comprising a paddle device having at least one paddle positioned at least proximate to the process location, wherein at least one of the at least one paddle and the workpiece support is movable relative to the other while the workpiece support carries a microfeature workpiece during processing.

[c18] 18. A system for processing microfeature workpieces, comprising:

a vessel configured to receive a processing fluid, the vessel having a process location positioned to receive a microfeature workpiece, the process location having a center;

a workpiece support positioned at least proximate to the vessel, the workpiece support being positioned to carry a microfeature workpiece at the process location of the vessel; and

an electric field control element positioned along a flow path between the electrode support and the process location, the electric field control element being configured to control an electrical current density in the processing fluid at the process location to have a first value at a first circumferential site of the process location and a second value different than the first value at a second circumferential site of the process location, the first and second circumferential sites being approximately the same distance from the center of the process location.

[c19] 19. The system of claim 18 wherein the electric field control element includes a slot having a first region with a first width and a second region with a second width greater than the first width.

[c20] 20. The system of claim 18 wherein the electric field control element includes a plurality of apertures, with apertures in a first region of the electric field control element providing a first open area and apertures in a second region of the electric field control element providing a second open area greater than the first open area.

[c21] 21. The system of claim 18 wherein the vessel includes vanes aligned along axes extending between the electric field control element and the process location.

[c22] 22. The system of claim 18 wherein the vessel includes a first portion and a second portion sealably coupled to the first portion, and wherein the electric field control element includes a gasket sealably positioned between the first and second portions.

[c23] 23. The system of claim 18, further comprising:

a paddle chamber in fluid communication with the vessel, the paddle chamber having an opening at the process location to receive a microfeature workpiece, and wherein the electric field control element forms a portion of the paddle chamber facing toward the opening; and

a paddle device disposed in the paddle chamber, the paddle device having at least one paddle positioned at least proximate to the process location, wherein at least one of the workpiece support and the at least one paddle is movable relative to the other to agitate

processing fluid at the process location while the workpiece support carries a microfeature workpiece.

[c24] 24. The system of claim 18, further comprising:

a paddle chamber in fluid communication with the vessel, the paddle chamber having an opening at the process location to receive a microfeature workpiece, and wherein the electric field control element is spaced apart from the paddle chamber; and

a paddle device disposed in the paddle chamber, the paddle device having at least one paddle positioned at least proximate to the process location, wherein at least one of the workpiece support and the at least one paddle is movable relative to the other to agitate processing fluid at the process location while the workpiece support carries a microfeature workpiece.

[c25] 25. The system of claim 18, further comprising:

a paddle chamber in fluid communication with the vessel, the paddle chamber having an opening at the process location to receive a microfeature workpiece; and

a paddle device disposed in the paddle chamber, the paddle device having at least one paddle positioned at least proximate to the process location, and wherein the at least one paddle is elongated along a paddle axis and movable relative to the process location along a motion axis transverse to the paddle axis, further wherein the electric field control element has a first flow-through area in regions aligned with the paddle axis and a second flow-through area less than the first in regions aligned with the motion axis.

[c26] 26. A system for processing microfeature workpieces, comprising:

a vessel configured to receive a processing fluid, the vessel having a process location positioned to receive a microfeature workpiece;

a workpiece support positioned at least proximate to the vessel, the workpiece support being positioned to carry a microfeature workpiece at the process location of the vessel and to rotate the microfeature workpiece relative to the vessel; and

a paddle device having at least one paddle positioned at least proximate to the process location, wherein at least one of the at least one paddle and the workpiece support is movable relative to the other along a generally linear motion axis while the workpiece support carries a microfeature workpiece.

[c27] 27. The system of claim 26 wherein the process location is positioned at a process plane and wherein the at least one paddle includes a plurality of paddles having spaced apart paddle surfaces.

[c28] 28. The system of claim 26, further comprising a magnet positioned at least proximate to the process location to orient magnetically sensitive material as it is deposited on the microfeature workpiece, and wherein the workpiece support is rotatable to orient the microfeature workpiece relative to the magnet for receiving the magnetically sensitive material.

[c29] 29. A method for processing a microfeature workpiece, comprising:

positioning a microfeature workpiece in contact with a processing fluid at a process plane of a process vessel;

processing the microfeature workpiece at the process plane by directing at least a portion of the processing fluid toward the microfeature workpiece to electrolytically deposit a magnetically sensitive material on the microfeature workpiece while the microfeature workpiece is

subjected to a magnetic field at the process plane and while the microfeature workpiece is in fluid communication with at least one electrode; and

removing the at least one electrode from fluid communication with the process plane without passing the at least one electrode through the process plane.

[c30] 30. The method of claim 29 wherein removing the at least one electrode includes removing an electrode housing carrying a plurality of electrodes.

[c31] 31. A method for processing a microfeature workpiece, comprising:

positioning a microfeature workpiece in contact with a processing fluid at a process plane of a process vessel, the process plane being at least proximate to a paddle device having at least one paddle;

processing the microfeature workpiece at the process plane by directing at least a portion of the processing fluid toward the microfeature workpiece to electrolytically deposit a material on the microfeature workpiece;

agitating the processing fluid proximate to the microfeature workpiece by moving at least one of the microfeature workpiece and the at least one paddle; and

drawing current through the processing fluid to a thieving electrode spaced apart from the process plane to reduce a rate at which material is added to and/or removed from a portion of the microfeature workpiece.

[c32] 32. The method of claim 31, further comprising coupling the thieving electrode and the microfeature workpiece to electrical potentials having the same polarity.

[c33] 33. The method of claim 31 wherein agitating the processing fluid includes moving a plurality of paddles relative to the microfeature workpiece.

[c34] 34. A method for processing microfeature workpieces, comprising:

positioning a microfeature workpiece in contact with a processing fluid at a process plane of a process vessel, the process plane being at least proximate to a paddle device having at least one paddle;

electrolytically depositing a material on the microfeature workpiece by directing at least a portion of the processing fluid toward the microfeature workpiece and adjacent to a plurality of electrodes positioned in a plurality of electrode chambers at least partially separated from each other by barriers, with gaps between the barriers forming a corresponding plurality of virtual electrode locations spaced apart from the process plane; and

agitating the processing fluid proximate to the microfeature workpiece by moving at least one of the microfeature workpiece and the paddle device.

[c35] 35. The method of claim 34 wherein agitating the processing fluid includes moving a plurality of paddles relative to the microfeature workpiece along a generally linear motion path.

[c36] 36. A method for processing microfeature workpieces, comprising:

carrying a microfeature workpiece at least proximate to a vessel;

positioning the microfeature workpiece in contact with a processing fluid at a process location of a process vessel, the process location being at least proximate to a paddle device having at least one paddle;

processing the microfeature workpiece at the process location by directing at least a portion of the processing fluid toward the microfeature workpiece;

agitating the processing fluid proximate to the microfeature workpiece by moving at least one of the microfeature workpiece and the at least one paddle; and

rotating the microfeature workpiece while the microfeature workpiece is at least proximate to the process location.

[c37] 37. The method of claim 36 wherein rotating the microfeature workpiece includes placing the microfeature workpiece in a selected alignment relative to the process vessel.

[c38] 38. The method of claim 36 wherein rotating the microfeature workpiece includes rotating the microfeature workpiece to have a selected orientation relative to a magnet positioned proximate to the process location, and wherein processing the microfeature workpiece includes depositing a magnetically sensitive material on the microfeature workpiece.

[c39] 39. The method of claim 36 wherein rotating the microfeature workpiece includes rotating the microfeature workpiece while rinsing the microfeature workpiece and after disposing a material from the processing fluid onto the microfeature workpiece.